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Compact Video Driver Series for DSCs and Portable Devices

Ultra-compact Waferlevel Chip Size Packeage Output Capacitor-less Single Output Video Drivers

BH76906GU, BH76909GU, BH76912GU, BH76916GU, BH76706GU

No. 09064EAT01

●Description

Due to a built-in charge pump circuit, this video driver does not require the large capacity tantalum capacitor at the video output pin that is essential in conventional video drivers. Features such as a built-in LPF that has bands suited to mobile equipment, current consumption of 0 µA at standby, and low voltage operation from as low as 2.5 V make it optimal for digital still cameras, mobile phones, and other equipment in which high density mounting is demanded.

●Features

1) WLCSP ultra-compact package (1.6 mm x 1.6 mm x 0.75 mm)
2) Improved noise characteristics over BH768xxFVM series
3) Four video driver amplifier gains in lineup: 6 dB, 9 dB, 12 dB, 16.5 dB
4) Large output video driver of maximum output voltage 5.2 Vpp. Ample operation margin for supporting even low voltage operation
5) Output coupling capacitor not needed, contributing to compact design
6) Built-in standby function and circuit current of 0 µA (typ) at standby
7) Clear image playback made possible by built-in 8^{th}-order 4.5 MHz LPF
8) Due to use of bias input format, supports not only video signals but also chroma signals and RGB signals
9) Due to built-in output pin shunt switch, video output pin can be used as video input pin (BH76706GU)

●Applications

Mobile phone, digital still camera, digital video camera, hand-held game, portable media player

●Line up matrix

Product Name	Video Driver Amplifier Gain	Recommended Input Level	Video Output Pin Shunt Function
BH76906GU	6dB	1Vpp	—
BH76909GU	9dB	0.7Vpp	
BH76912GU	12dB	0.5Vpp	
BH76916GU	16.5dB	0.3Vpp	
BH76706GU	6dB	1Vpp	○

●Absolute Maximum Ratings (Ta = 25 °C)

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	3.55	V
Power dissipation	P_d	580	mW
Operating temperature range	T_{opr}	-40～+85	℃
Storage temperature range	T_{stg}	-55～+125	℃

＊ When mounted on a 50 mm×58 mm×1.6 mm glass epoxy board, reduce by 5.8mW/°C above Ta=+25°C.

●Operating Range

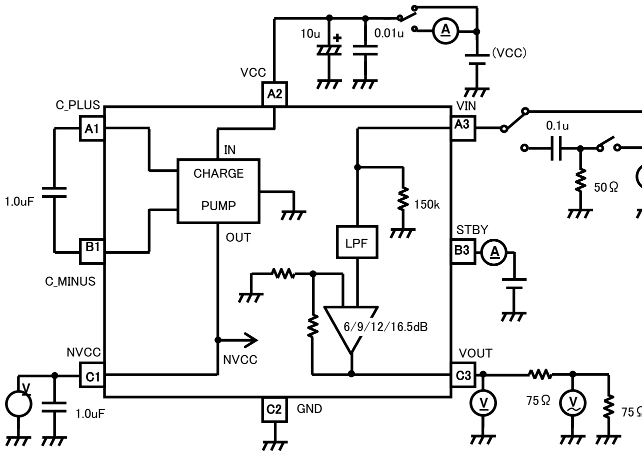
Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}	2.5	3.0	3.45	V

●Electrical Characteristics

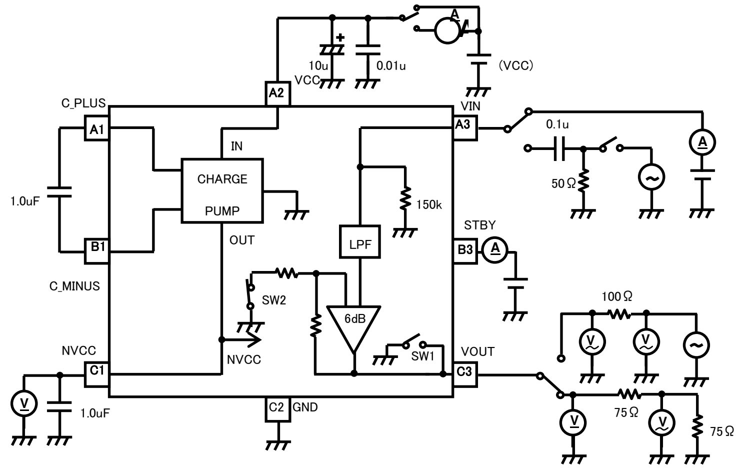
[Unless otherwise specified, Typ. : T_a = 25 °C, VCC = 3V]

Parameter	Symbol	Typical Values					Unit	Measurement Conditions
		BH76906GU	BH76909GU	BH76912GU	BH76916GU	BH76706GU		
Circuit current 1-1	I_{CC1-1}	15.0					mA	In active mode (No signal)
Circuit current 1-2	I_{CC1-2}	17.0					mA	In active mode (Outputting NTSC color bar signal)
Circuit current 2	I_{CC2}	0.0					μA	In standby mode
Circuit current 3	I_{CC3}	—				100	μA	In input mode (Applying B3 = 1.5 V)
Standby switch input current High Level	I_{thH1}	45				—	μA	Applying B3 = 3.0 V
Standby switch switching voltage High Level	V_{thH1}	1.2V min					V	Active mode
Standby switch switching voltage Low Level	V_{thL1}	0.45Vmax					V	Standby mode
Standby switch outflow current High Level	I_{thH2}	—				0	μA	Applying B3 = 3.0 V
Standby switch outflow current Middle Level	I_{thM2}					8	μA	Applying B3 = 1.5 V
Standby switch outflow current Low Level	I_{thL2}					23	μA	Applying B3 = 0 V
Mode switching voltage High Level	V_{thH2}					VCC -0.2 (MIN.)	V	Standby mode
Mode switching voltage Middle Level	V_{thM2}					VCC/2 (TYP.)	V	Input mode
Mode switching voltage low Level	V_{thL2}					0.2 (MAX.)	V	Active mode
Voltage gain	G_V	6.0	9.0	12.0	16.5	6.0	dB	Vo=100kHz, 1.0Vpp
Maximum output level	V_{omv}	5.2					Vpp	f=10kHz,THD=1%
Frequency characteristic 1	G_{f1}	-0.2				-0.2	dB	f=4.5MHz/100KHz
Frequency characteristic 2	G_{f2}	-1.5				-1.4	dB	f=8.0MHz/100KHz
Frequency characteristic 3	G_{f3}	-26				-28	dB	f=18MHz/100KHz
Frequency characteristic 4	G_{f4}	-44				-48	dB	f=23.5MHz/100KHz
Differential gain	D_G	0.5					%	Vo=1.0Vp-p Inputting standard staircase Signal
Differential phase	D_P	1.0					deg	Vo=1.0Vp-p Inputting standard staircase signal
Y signal to noise ratio	SN_Y	+74	+73	+70	+70	+74	dB	100 kHz～6MHz band Inputting 100% white video signal
C AM signal to noise ratio	SN_{CA}	+77	+76	+75	+75	+77	dB	100～500 kHz band Inputting 100% chroma video signal
C PM signal to noise ratio	SN_{CP}	+65					dB	100～500 kHz band Inputting 100% chroma video signal
Current able to flow into output pin	Iextin	30					mA	Applying 4.5 V to output pin through 150 Ω
Output DC offset	Voff	±50max					mV	With no signal Voff = (Vout pin voltage) ÷ 2
Input impedance	Rin	150					kΩ	Measure inflowing current when applying A3 = 1 V
Output pin shunt switch on resistance	Ron	—				3	Ω	

●Test Circuit Diagram



(a) BH76906/09/12/16GU

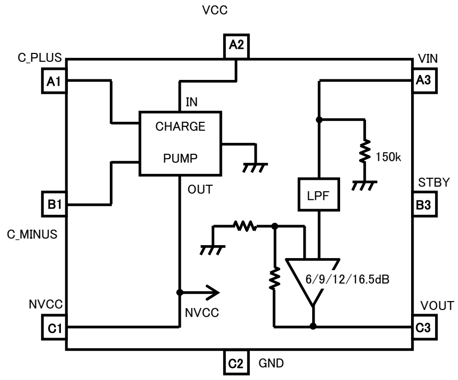


(b) BH76706GU

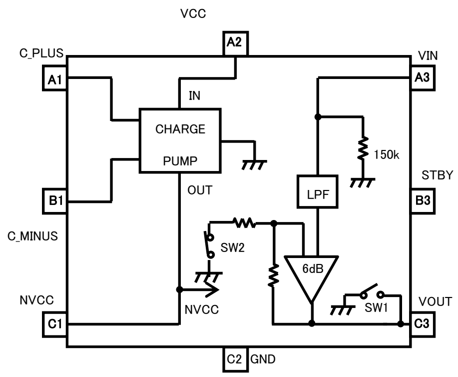
Fig. 1

※ A test circuit is a circuit for shipment inspection and differs from an application circuit example.

●Block Diagram



(a) BH76906/09/12/16GU



(b) BH76706GU

Fig. 2

●Operation Logic

BH769xxGU

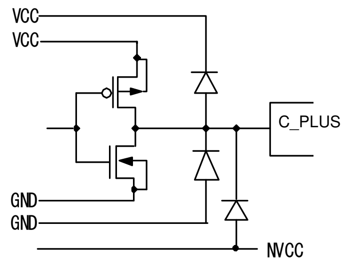
STBY Pin Logic	Operating Mode
H	Active
L	Standby
OPEN	

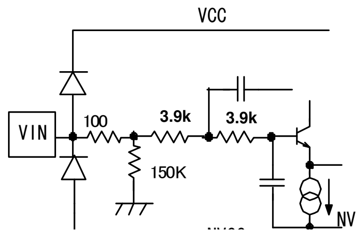
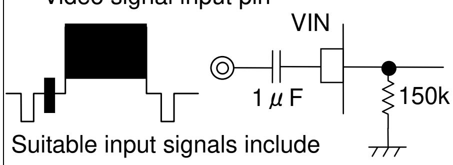
BH76706GU

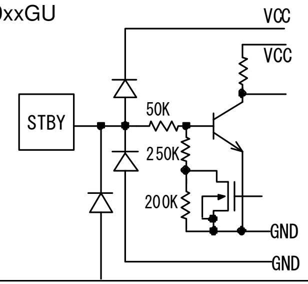
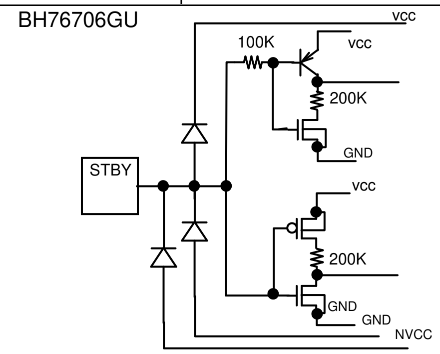
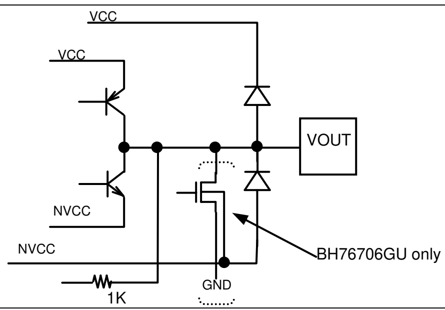
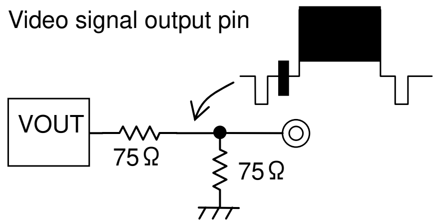
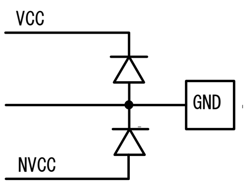
STBY Pin Logic	Operating Mode	SW1	SW2
H	Standby	OFF	OFF
M	Input (Record)	ON	OFF
L	Active (Playback)	OFF	ON

※Use of the BH76706GU with the STBY pin OPEN is inappropriate

●Pin Descriptions

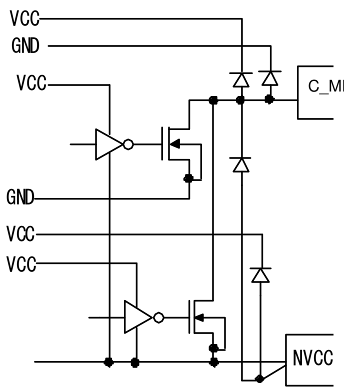
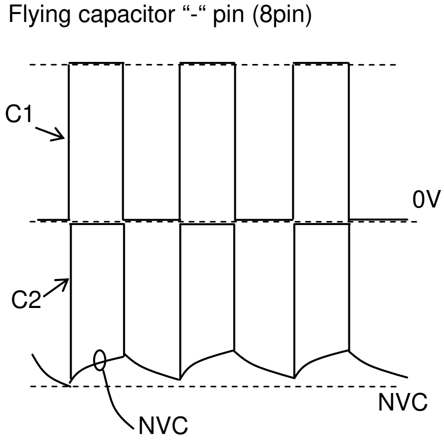
<table>
<tr><th>Ball</th><th>Pin Name</th><th>Pin Internal Equivalent Circuit Diagram</th><th>DC Voltage</th><th>Functional Description</th></tr>
<tr><td>A1</td><td>C_PLUS</td><td>
</td><td>+VCC
↑ ↓
0V</td><td>Flying capacitor "+" pin

See functional descriptions of 7pin, 8pin</td></tr>
<tr><td>A2</td><td>VCC</td><td></td><td>VCC</td><td>VCC pin</td></tr>
<tr><td>A3</td><td>VIN</td><td>
</td><td>0V</td><td>Video signal input pin


Suitable input signals include composite video signals, chroma signals, R.G.B. signals</td></tr>
<tr><td rowspan="2">B3</td><td rowspan="2">STBY</td><td>BH769xxGU

</td><td rowspan="2">VCC
to
0V</td><td>ACTIVE/STANBY switching pin<table><tr><th>Pin Voltage</th><th>MODE</th></tr><tr><td>1.2 V～VCC
(H)</td><td>ACTIVE</td></tr><tr><td>0 V～0.45 V
(L)</td><td>STANBY</td></tr></table></td></tr>
<tr><td>BH76706GU

</td><td>MODE switching pin<table><tr><th>Pin Voltage</th><th>MODE</th></tr><tr><td>2.8 V～VCC
(H)</td><td>STANBY</td></tr><tr><td>1.3 V～1.7 V
(M)</td><td>GND (Record)</td></tr><tr><td>0 V～0.2 V
(L)</td><td>ACTIVE
(Playback)</td></tr></table></td></tr>
<tr><td>C3</td><td>VOUT</td><td>
</td><td>0V</td><td>Video signal output pin

</td></tr>
<tr><td>C2</td><td>GND</td><td>
</td><td>0V</td><td>GND pin</td></tr>
</table>

Note 1) DC voltages in the figure are those when VCC ＝ 3.0 V. Moreover, these values are reference values which are not guaranteed.

Note 2) Numeric values in the figure are settings which do not guarantee ratings.

C1	NVCC		-VCC (-2.75 V)	
B1	C_MINUS		0V ↑ ↓ -VCC (-2.75 V)	

Note 1) DC voltages in the figure are those when VCC = 3.0 V. Moreover, these values are reference values which are not guaranteed.
Note 2) Numeric values in the figure are settings which do not guarantee ratings.

●Description of Operation

1) Principles of output coupling capacitorless video drivers

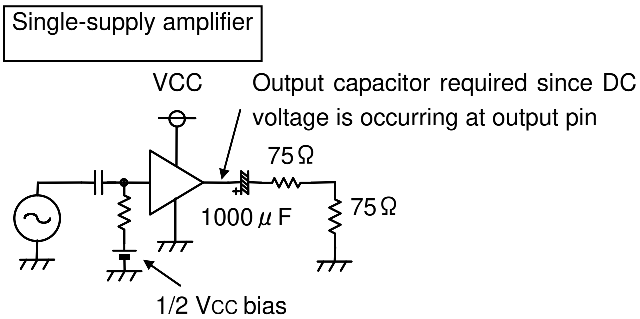


Fig.3

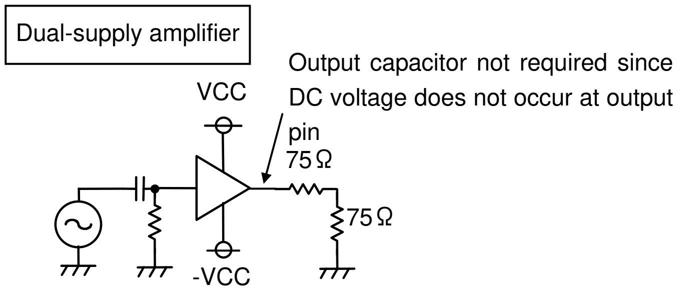


Fig.4

For an amplifier operated from a single power supply (single-supply), since the operating point has a potential of approximately 1/2 Vcc, a coupling capacitor is required for preventing direct current in the output. Moreover, since the load resistance is 150 Ω (75 Ω + 75 Ω) for the video driver, the capacity of the coupling capacitor must be on the order of 1000 μF if you take into account the low band passband. (Fig.3)

For an amplifier operated from dual power supplies (± supply), since the operating point can be at GND level, a coupling capacitor for preventing output of direct current is not needed.
Moreover, since a coupling capacitor is not needed, in principle, there is no lowering of the low band characteristic at the output stage. (Fig.4)

2) Occurrence of negative voltage due to charge pump circuit

A charge pump, as shown in Fig. 5, consists of a pair of switches (SW1, SW2) and a pair of capacitors (flying capacitor, anchor capacitor). Switching the pair of switches as shown in Fig. 5 causes a negative voltage to occur by shifting the charge in the flying capacitor to the anchor capacitor as in a bucket relay.
In this IC, by applying a voltage of +3 V, a negative voltage of approximately -2.8 V is obtained.

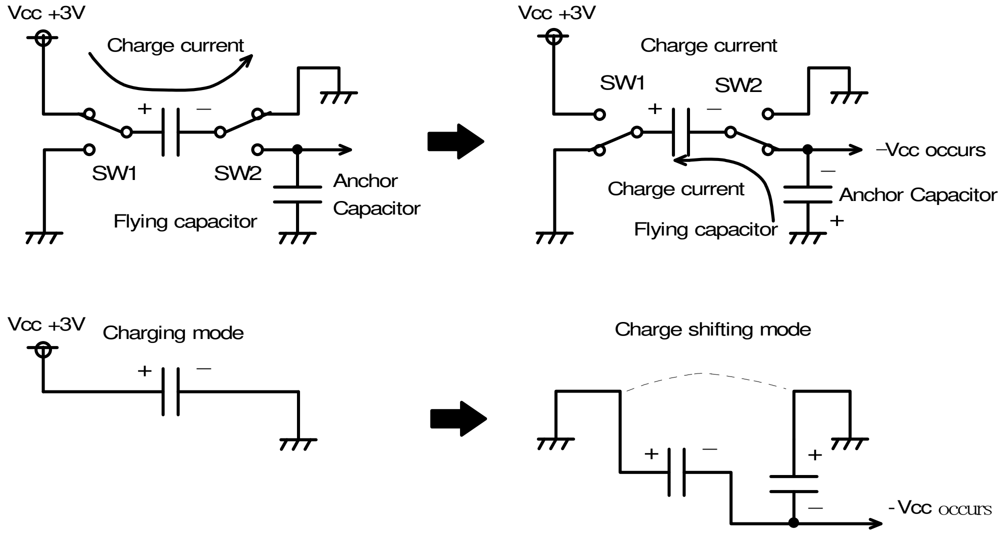


Fig.5 Principles of Charge Pump Circuit

3) Configuration of BH769xxGU and BH76706GU

As shown in Fig. 6, a BH769xxGU or BH76706GU is a dual-supply amplifier and charge pump circuit integrated in one IC. Accordingly, while there is +3 V single-supply operation, since a dual-supply operation amplifier is used, an output coupling capacitor is not needed.

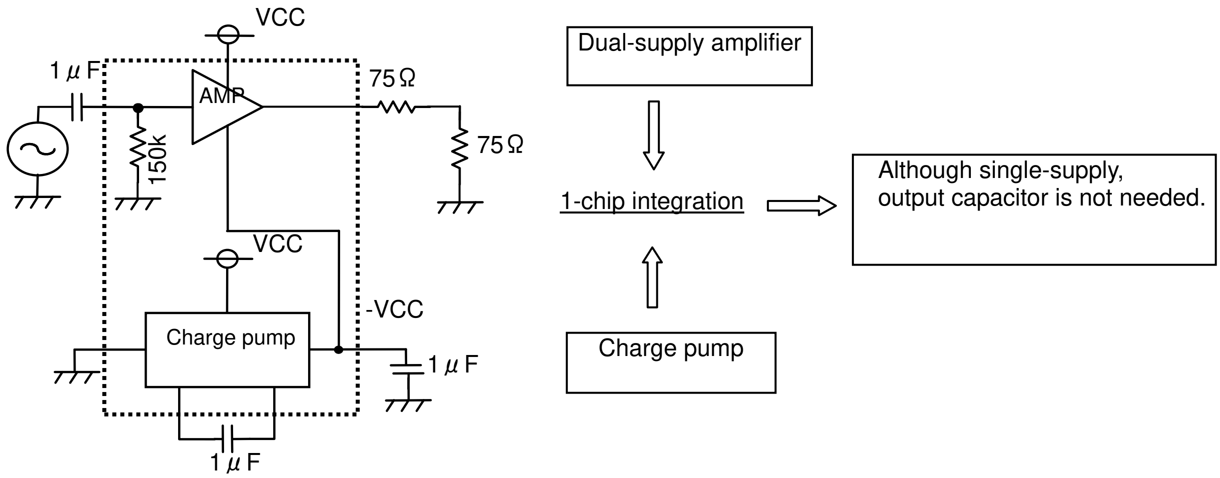


Fig.6 Configuration Diagram of BH769xxGU or BH76706GU

4) Input pin format and sag characteristic

While a BH769xxGU or BH76706GU is a low voltage operation video driver, since it has a large dynamic range of approximately 5.2 Vpp, a resistance termination method that is compatible regardless of signal form (termination by 150 kΩ) is used, and not a clamp method that is an input method exclusively for video signals.
Therefore, since a BH769xxGU or BH76706GU operates normally even if there is no synchronization signal in the input signal, it is compatible with not only normal video signals but also chroma signals and R.G.B. signals and has a wide application range.
Moreover, concerning sag (lowering of low band frequency) that occurs at the input pin and becomes a problem for the resistance termination method, since the input termination resistor is a high 150 kΩ, even if it is combined with a small capacity input capacitor, a sag characteristic that is not a problem in actual use is obtained.
In evaluating the sag characteristic, it is recommended that you use an H-bar signal in which sag readily stands out. (Fig. 8 to Fig. 10)

Input capacitor and input impedance cutoff frequency is the same as when output capacitor in generic 75 Ω driver is made 1000 μF.
1 μF x 150 kΩ = 1000 μF x 150 Ω
(Input pin time constant) (Output pin time constant)

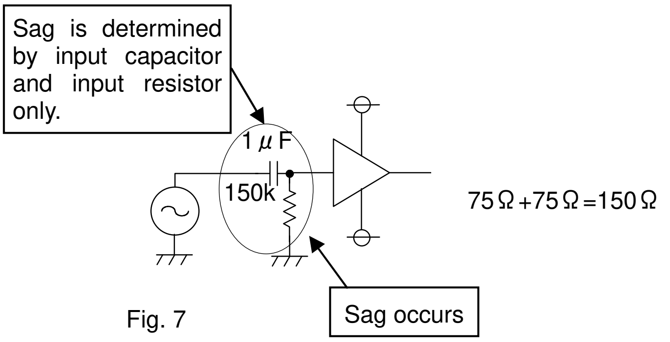
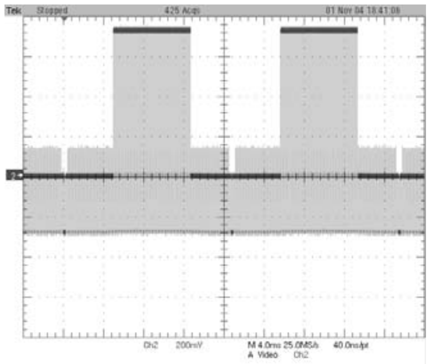


Fig. 7

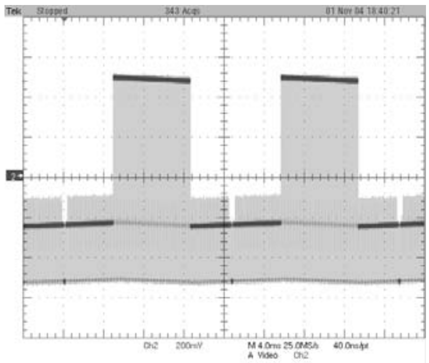
a) Video signal without sag (TG-7/1 output, H-bar)



TV screen output image of H-bar signal

Fig. 8

b) BH769xxGU or BH76706GU output (Input = 1.0 μF, TG-7/1 output, H-bar)



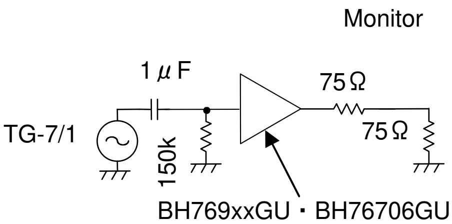
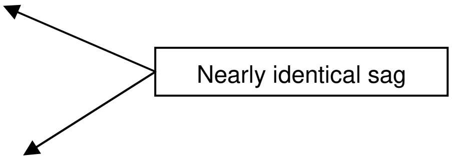
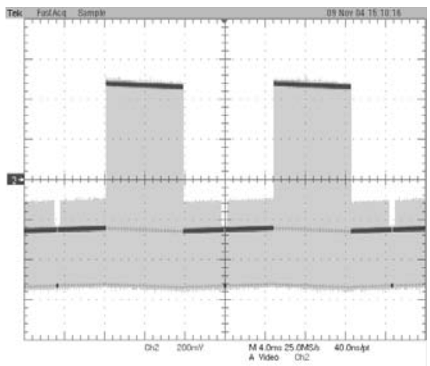


Fig. 9



c) 1000 μF + 150 Ω sag waveform (TG-7/1 output, H-bar)



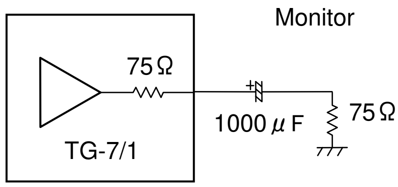
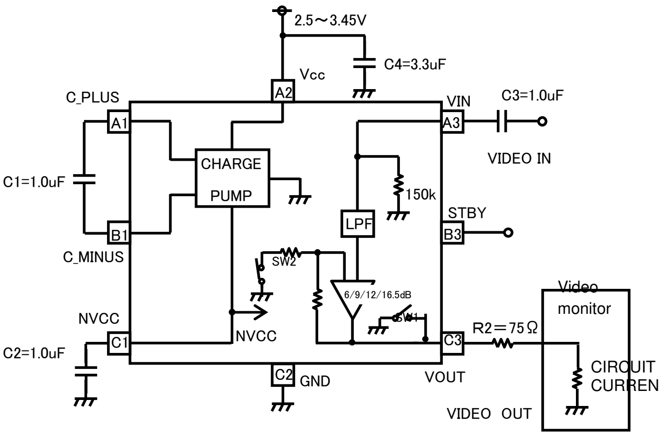


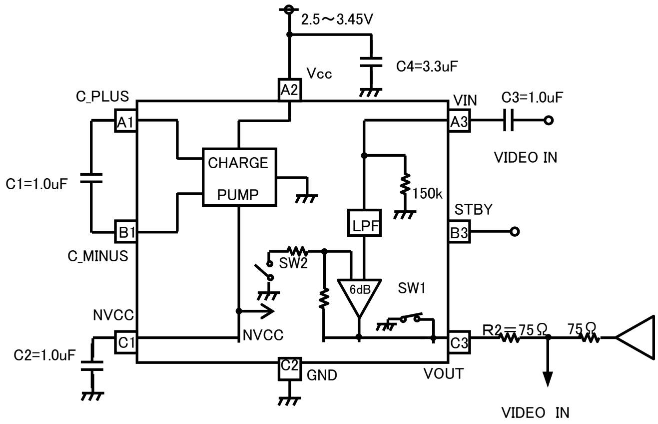
Fig. 10

●Application Circuit Example

At playback (Active mode)



Recording (Input mode) BH76706GU only



∗SW1 and SW2 are built-in BH76706GU only

See page 3/16 for STBY pin logic in each mode

Fig.11

※ We are confident in recommending the above application circuit example, but we ask that you carefully check not just the static characteristics but also transient characteristics of this circuit before using it.

●Caution on use

1. Wiring from the decoupling capacitor C4 to the IC should be kept as short as possible.
   Moreover, this capacitor's capacitance value may have ripple effects on the IC, and may affect the S-N ratio for signals, so we recommend using as large a decoupling capacitor as possible. (Recommended C4: 3.3 µF, B characteristics, 6.3 V or higher maximum voltage)
   Make mount board patterns follow the layout example shown on page 10 as closely as possible.

2. Capacitors to use
   In view of the temperature characteristics, etc., we recommend a ceramic capacitor with B characteristics.

3. The NVCC (C1 pin) terminal generates a voltage that is used within the IC, so it should never be connected to a load unless absolutely necessary. Moreover, this capacitor (C2) has a large capacitance value but very little negative voltage ripple.
   (Recommended C2: 1.0 µF, B characteristic, 6.3 V or higher maximum voltage)

4. Capacitors C1 and C4 should be placed as close as possible to the IC. If the wiring to the capacitor is too long, it can lead to intrusion of switching noise. (Recommended C1: 1.0 µF, B characteristics, 6.3 V or higher maximum voltage)

5. The HPF consists of input coupling capacitor C3 and 150 kΩ of internal input impedance.
   Be sure to check for video signal sag before determining the C3 value.
   The cut-off frequency fc can be calculated using the following formula.
   $fc = 1/(2\pi \times C3 \times 150k\Omega)$ (Recommended C3: 1.0 µF, B characteristic, 6.3 V or higher maximum voltage)

6. The output resistor R2 should be placed close to the IC.

7. If the IC is mounted in the wrong direction, there is a risk of damage due to problems such as inverting VCC and GND.
   Be careful when mounting it.

8. A large current transition occurs in the power supply pin when the charge pump circuit is switched. If this affects other ICs (via the power supply line), insert a resistor (approximately 10 Ω) in the VCC line to improve the power supply's ripple effects. Although inserting a 10 Ω resistor lowers the voltage by about 0.2 V, this IC has a wide margin for low-voltage operation, so dynamic range problems or other problems should not occur. (See Figures 12 to 14.)

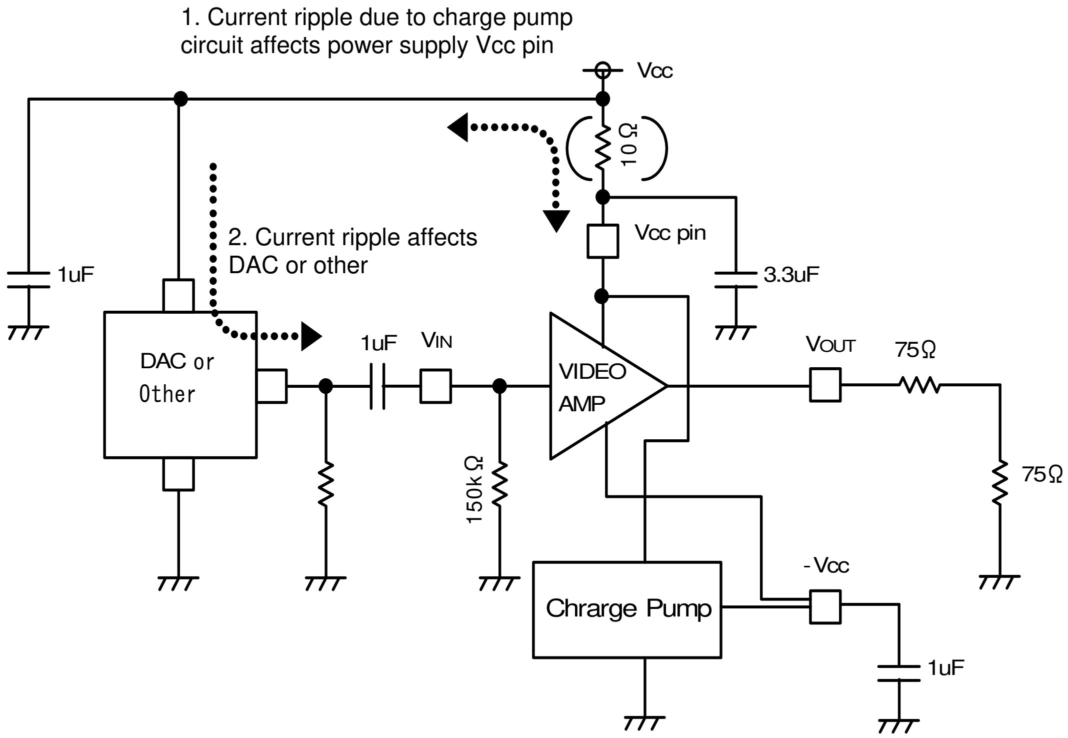
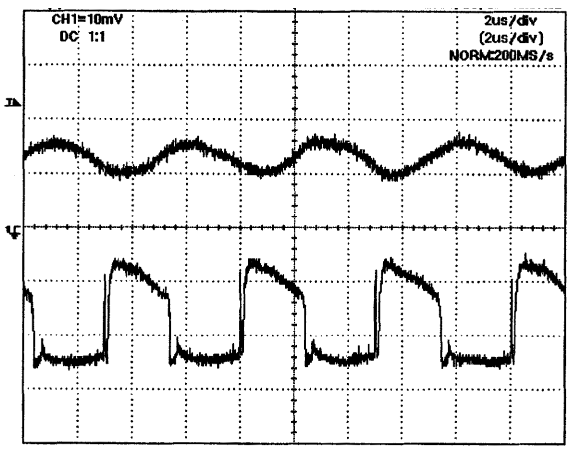


Fig.12 Effects of Charge Pump Circuit Current Ripple on External Circuit

1) Decoupling capacitor only



Waveform of current between power supply and capacitor (A)
10 mA/div

Waveform of current between capacitor and IC (B)
10 mA/div

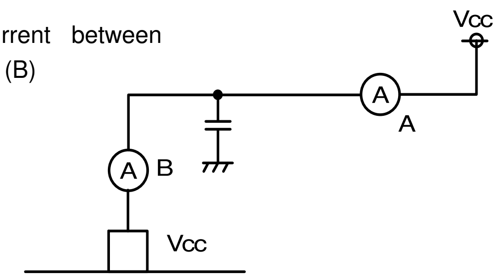
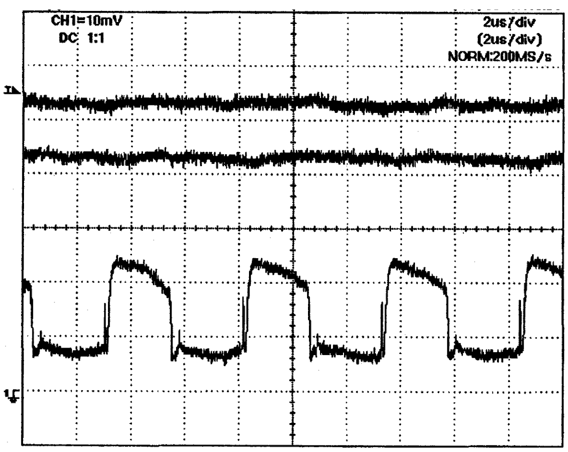


Fig.13

2) Decoupling capacitor + 10 Ω resistor



Waveform of current between power supply and capacitor (A)
10 mA/div
Waveform of current between resistor and capacitor (B)
10 mA/div
Waveform of current between capacitor and IC (C)
10 mA/div

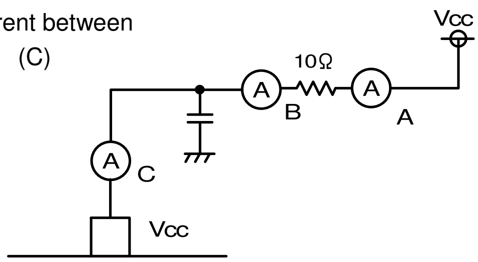
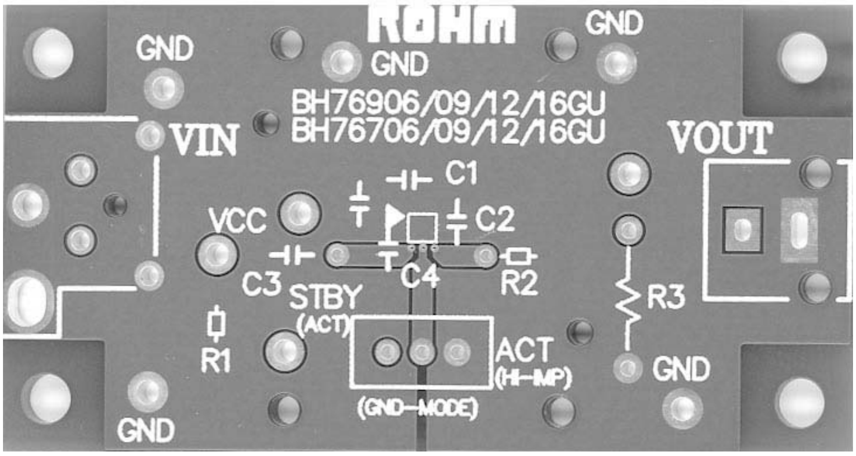
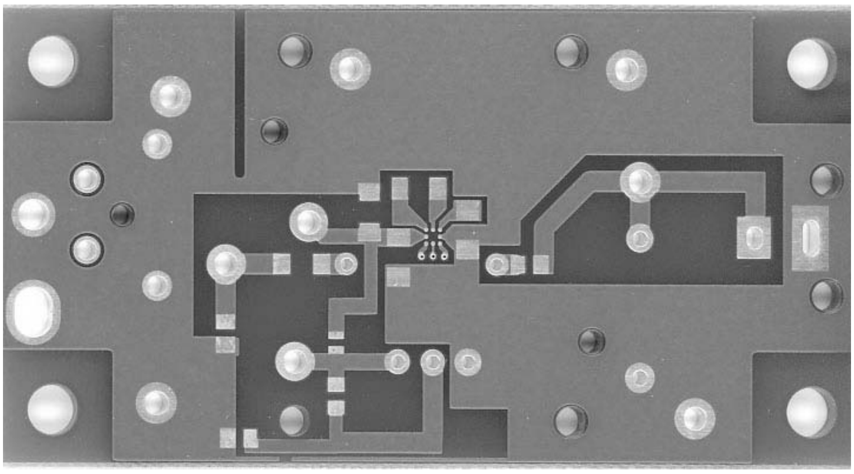


Fig.14

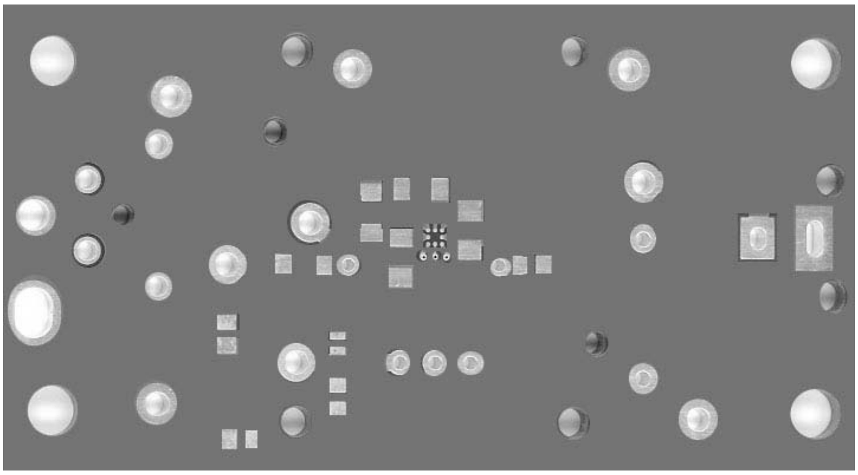
●Evaluation Board Pattern Diagram (Double-sided, 2 layers)



Layer 1 wiring + Silkscreen legend



Layer 2 wiring



Solder pattern

Fig.15

Parts List

Symbol	Function	Recommended Value	Remarks
C1	Flying capacitor	1 μF	B characteristic recommended
C2	Tank capacitor	1 μF	B characteristic recommended
C3	Input coupling capacitor	1 μF	B characteristic recommended
C4	Decoupling capacitor	3.3 μF	B characteristic recommended
R1	Input termination resistor	75 Ω	Needed when connected to video signal measurement set
R2	Output resistor	75 Ω	—
R3	Output termination resistor	75 Ω	Not needed when connected to TV or video signal measurement set
	Input connector	BNC	
	Output connector	RCA (Pin jack)	

●Reference Data

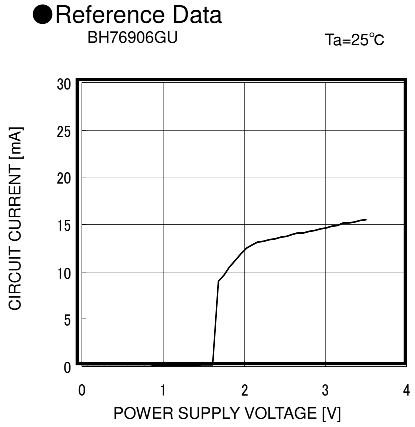


Fig. 16 Circuit Current vs Supply Voltage

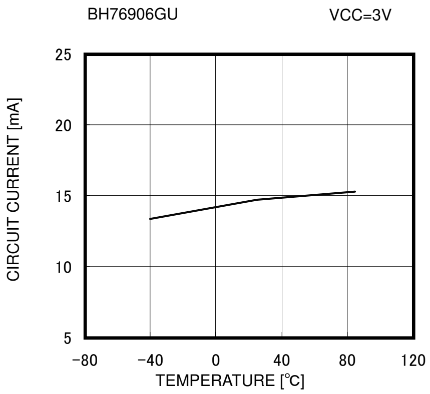


Fig. 17 Circuit Current vs Ambient Temperature

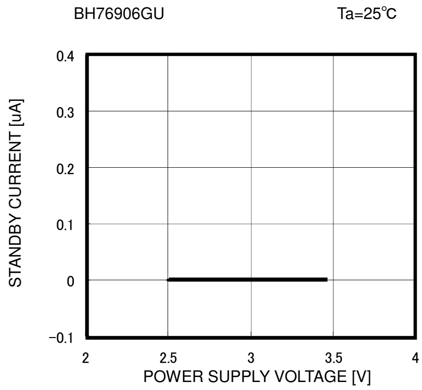


Fig. 18 Standby Circuit Current vs Supply Voltage

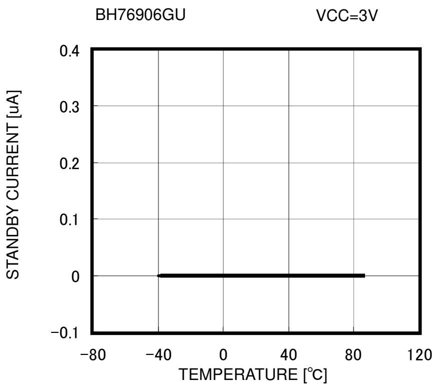


Fig. 19 Standby Circuit Current vs Ambient Temperature

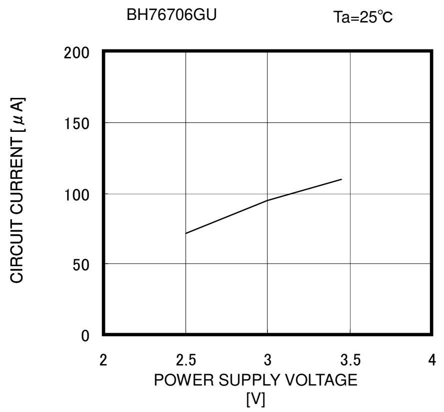
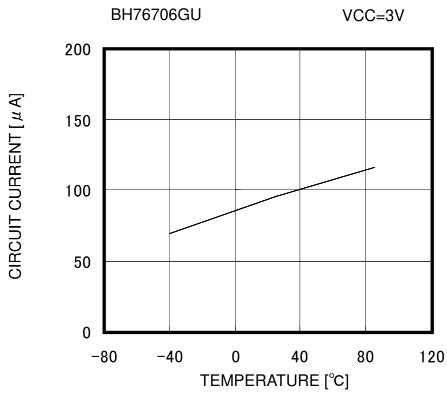


Fig. 20 GND Mode Circuit Current vs Supply Voltage



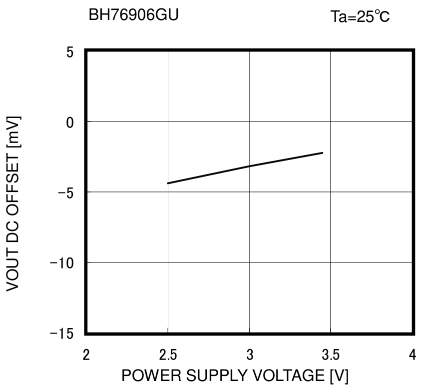


Fig. 22 VOUT Pin Output DC Offset vs Supply Voltage

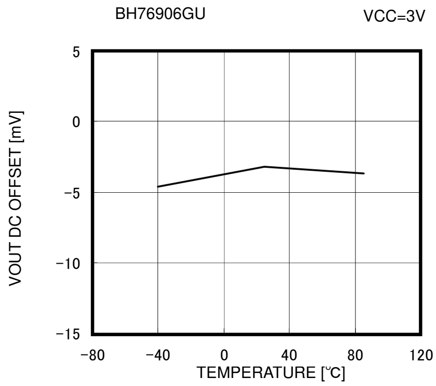


Fig. 23 VOUT Pin Output DC Offset vs Ambient Temperature

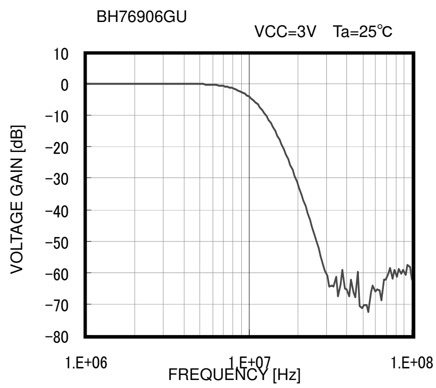


Fig. 24 Frequency Characteristic

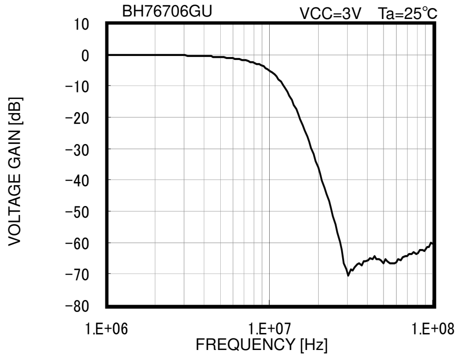


Fig. 25 Frequency Characteristic

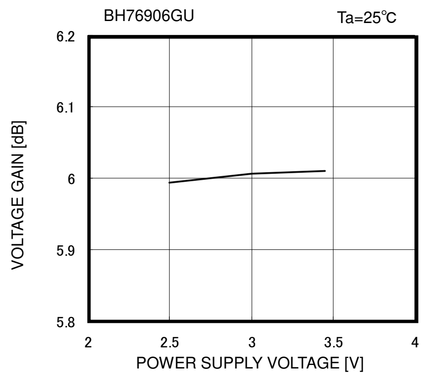


Fig. 26 Voltage Gain vs Supply Voltage

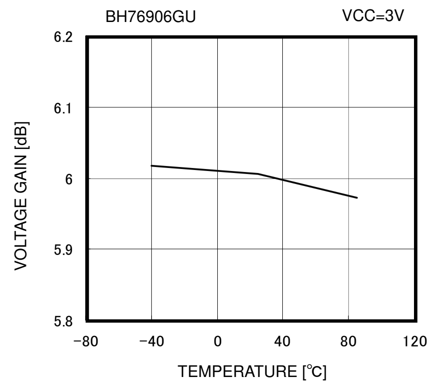


Fig. 27 Voltage Gainvs Ambient Temperature

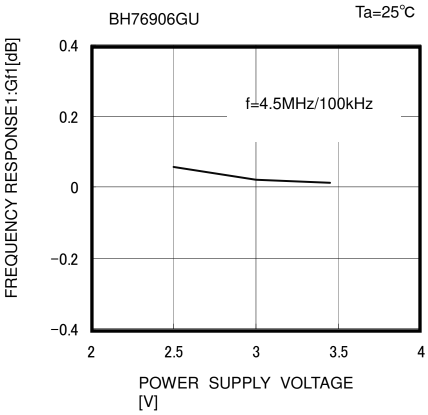


Fig. 28 Frequency Characteristic 1 vs Supply Voltage

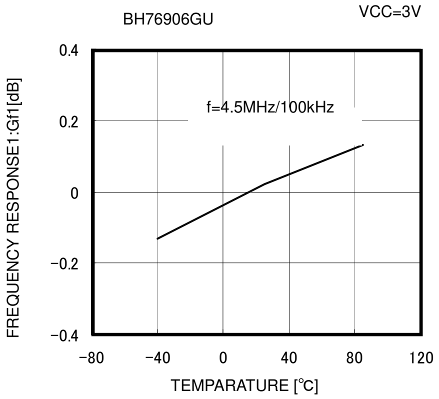


Fig. 29 Frequency Characteristic 1 vs Ambient Temperature

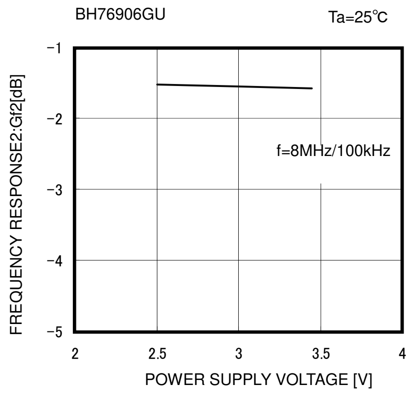


Fig. 30 Frequency Characteristic 2 vs Supply Voltage

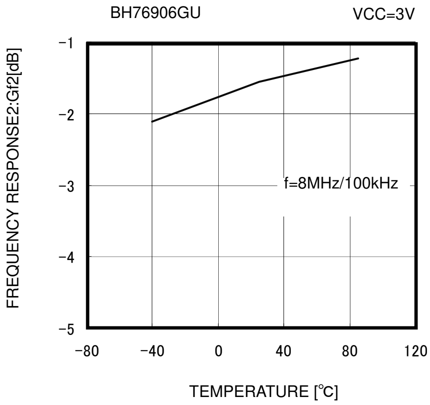


Fig. 31 Frequency Characteristic 2 vs Ambient Temperature

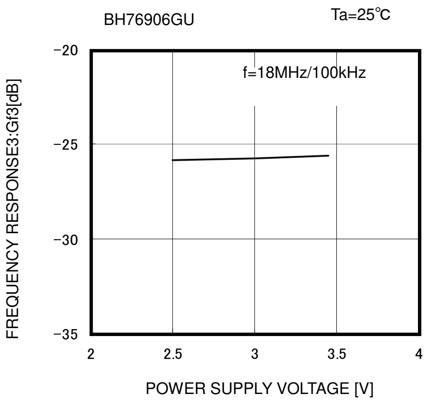
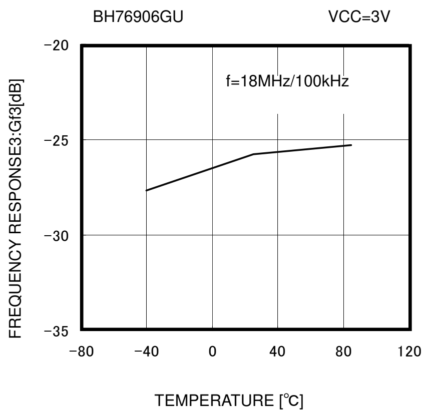


Fig.32 Frequency Characteristic 3 vs Supply Voltage



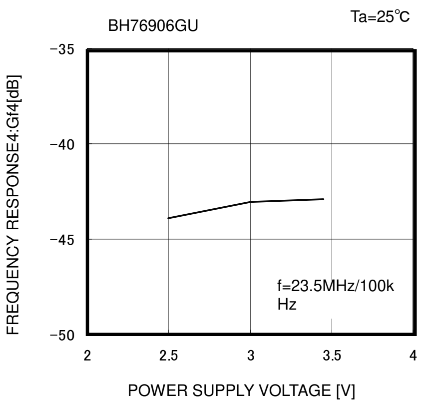


Fig. 34 Frequency Characteristic4 vs Supply Voltage

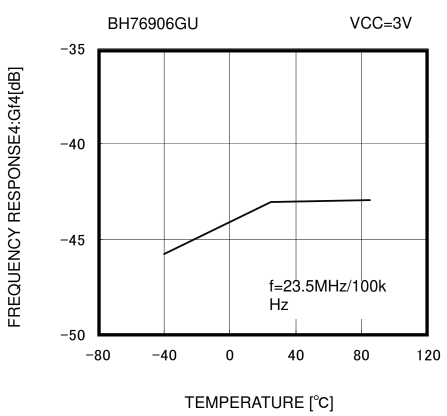
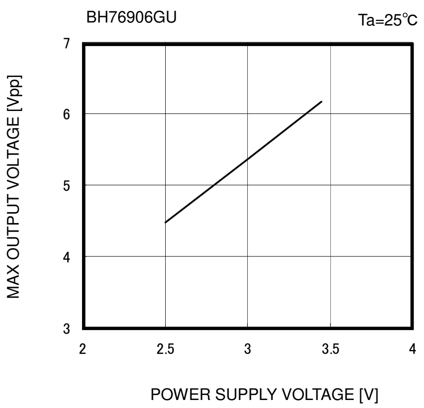


Fig. 35 Frequency Characteristic 4 vs Ambient Temperature



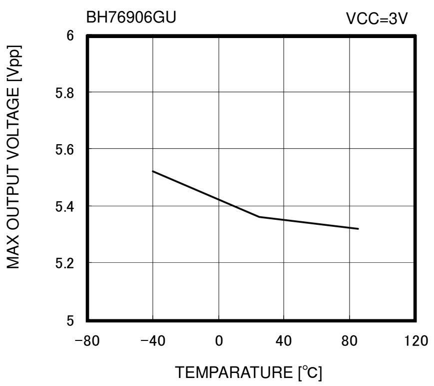


Fig. 37 Max. Output Level vs Ambient Temperature

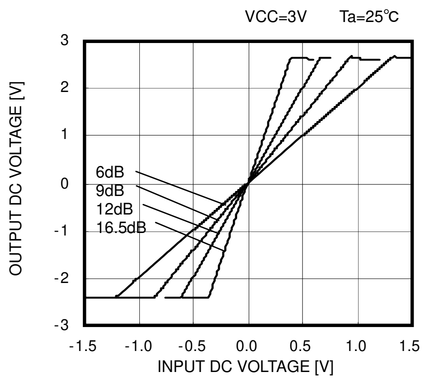


Fig. 38 DC I/O Characteristic

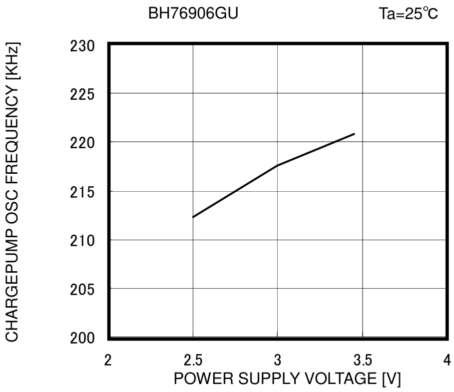


Fig. 39 Charge Pump Oscillation Frequency vs Supply Voltage

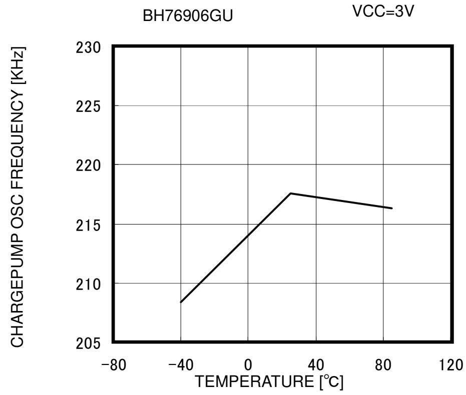


Fig. 40 Charge Pump Oscillation Frequency vs Ambient Temperature

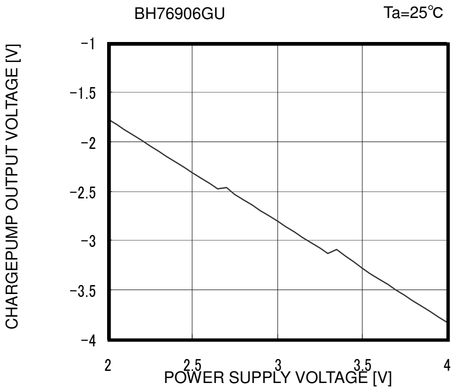


Fig. 41 Charge Pump Output Voltage vs Supply Voltage

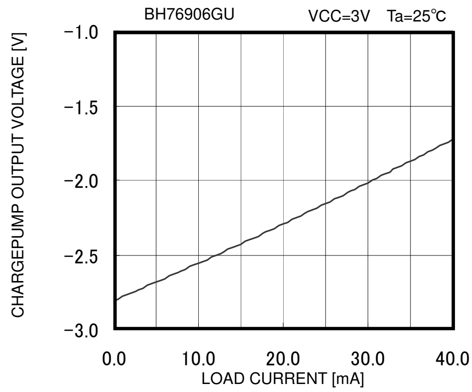


Fig. 42 Charge Pump Load Regulation

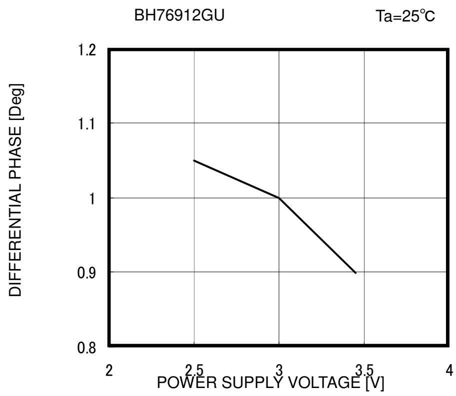
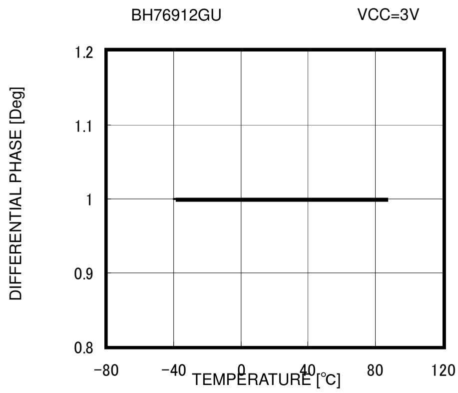


Fig. 43 Differential Phase vs Supply Voltage



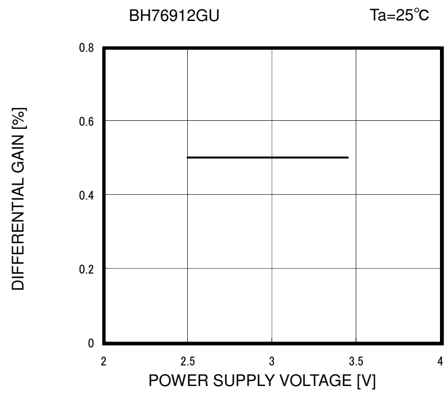


Fig. 45 Differential Gain vs Supply Voltage

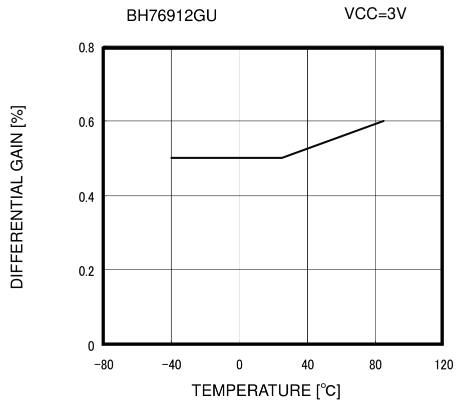


Fig. 46 Differential Gain vs Ambient Temperature

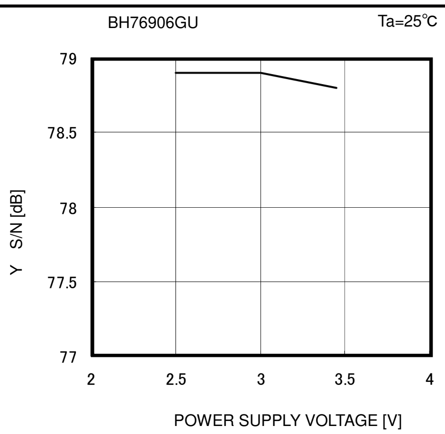


Fig. 47 Y S/N vs Supply Voltage

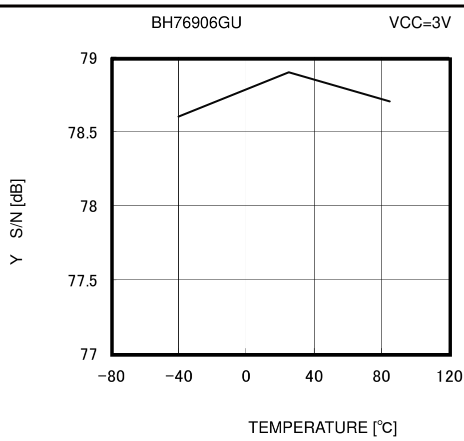


Fig.48 Y S/N vs Ambient Temperature

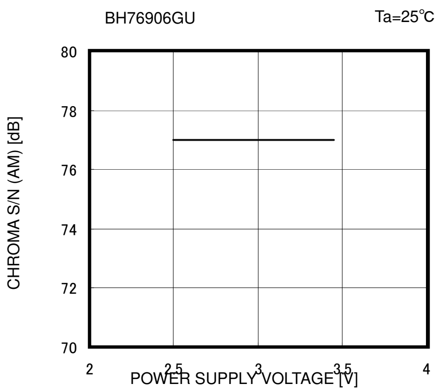


Fig. 49 C AM S/N vs Supply Voltage

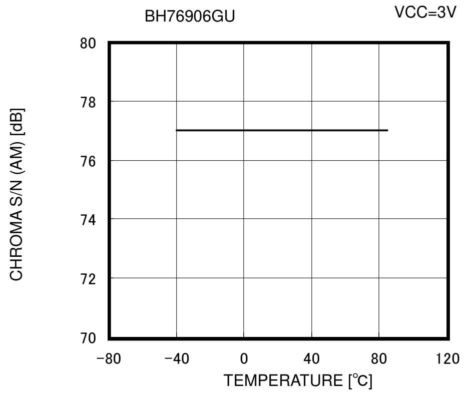


Fig. 50 C AM S/N vs Ambient Temperature

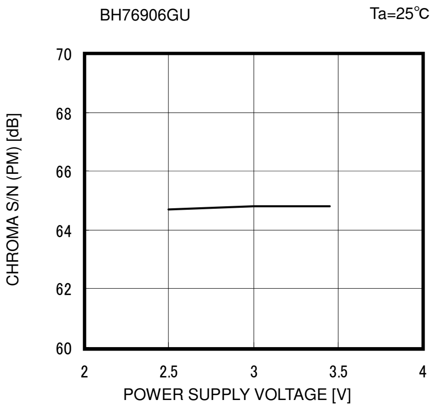


Fig. 51 C PM S/N vs Supply Voltage

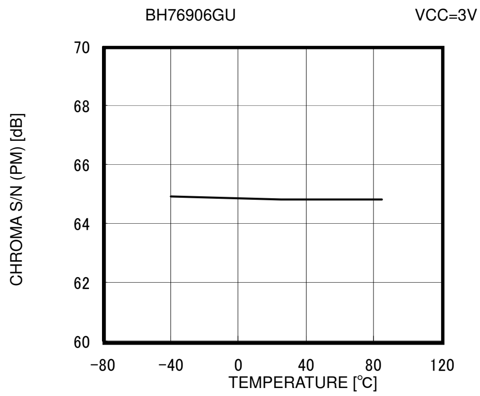


Fig. 52 C PM S/N vs Ambient Temperature

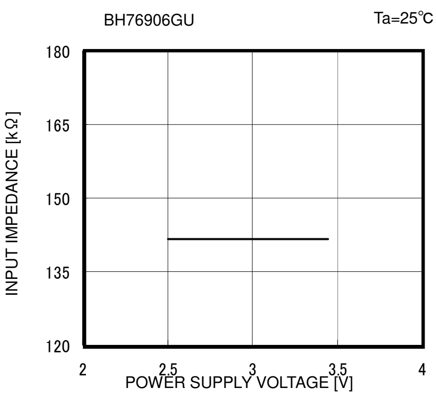


Fig. 53 Input Impedance vs Supply Voltage

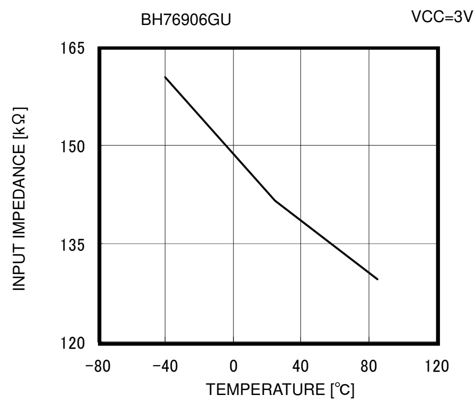


Fig. 54 Input Impedance vs Ambient Temperature

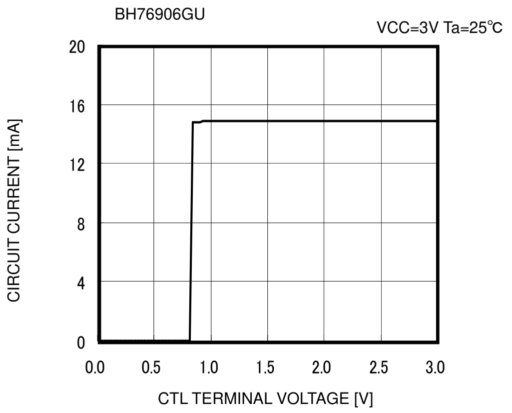


Fig. 55 Control Pin Characteristic

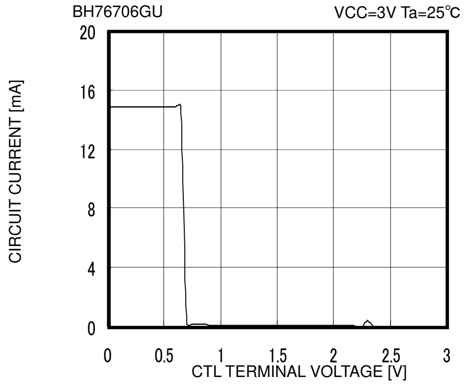


Fig. 56 Control Pin Characteristic

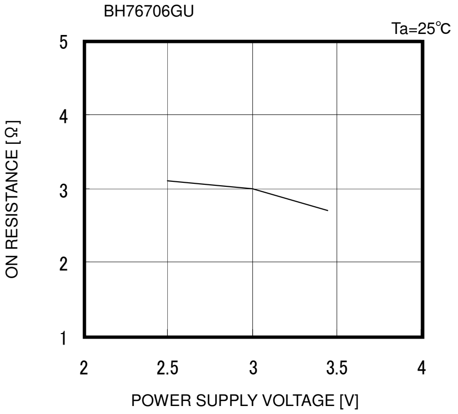


Fig. 57 Output Pin Shunt Switch On Resistance vs Supply Voltage

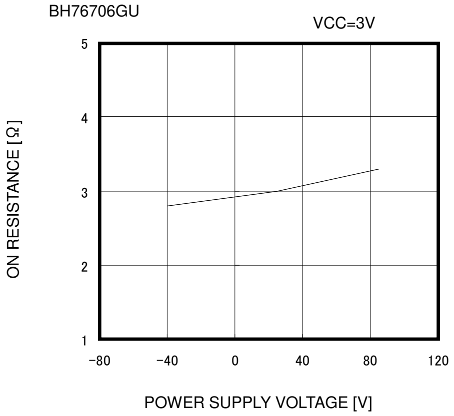


Fig. 58 Output Pin Shunt Switch On Resistance vs Ambient Temperature

● Performing separate electrostatic damage countermeasures
When adding an externally attached electrostatic countermeasure element to the output pin, connect a varistor in the position shown in Fig. 59 (if connected directly to the output pin, the IC could oscillate depending on the capacity of the varistor). For this IC, since the output waveform is GND-referenced and swings positive and negative, a normal Zener diode cannot be used.

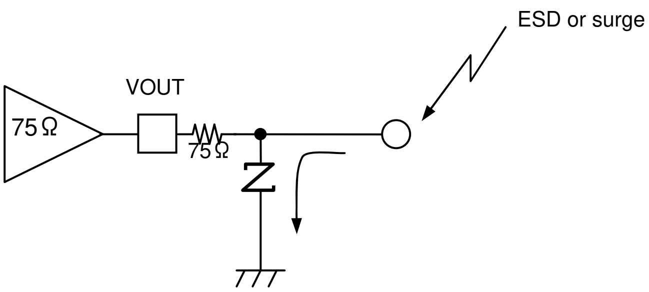


Fig.59 Using Externally Attached Varistor

●Selection of order type

B	H	7	6	9	0	6	G	U	—	E	2

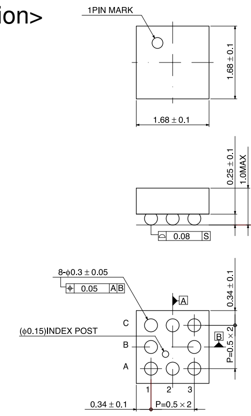
Part. No.

BH76906GU
BH76909GU
BH76912GU
BH76916GU
BH76706GU

Tape and Reel information

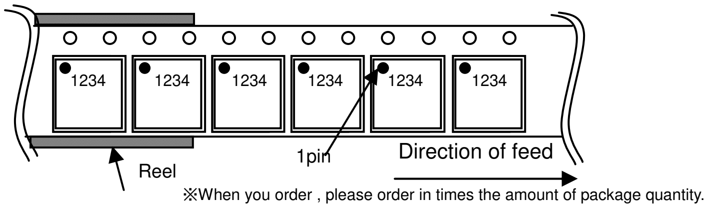
VCSP85H1

<Dimension>



(Unit:mm)

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



※When you order , please order in times the amount of package quantity.

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